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Report

HMI Style Guide and Toolkit

This guide provides simple and practical guidance to plant system Instrumentation and Control (I&C) responsible officers and designers on how to design, develop, procure, operate and maintain an effective plant system operator user interface.

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v3.2	Approved	18 Feb 2015	Support of ITER Human Factor requirements for HMI development (QEDG6L)	
v3.1	Disapproved	04 Feb 2015	Implemented the comment from Nadine on missing Pop-up boxes images.	
v3.0	Signed	30 Jan 2015	This document sets out the designs for human-machine interfaces (HMI) that ITER personnel will use to monitor and control the ITER systems during phases of commissioning, operation, and maintenance. The ITER Human Factors Integration Plan (IHFIP) identified the need for a HMI Development Process that included this HMI design guide to achieve high user reliability, efficiency, and effectiveness by enforcing high standards for human-system interface design consistently across ITER.	
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1 Introduction

1.1 PCDH Context

The Plant Control Design Handbook (PCDH) [RD1] defines methodology, standards, specifications and interfaces applicable to ITER plant systems Instrumentation & Control (I&C) system life cycle. I&C standards are essential for ITER to:

- Integrate all plant systems into one integrated control system.
- Maintain all plant systems after delivery acceptance.
- Contain cost by economy of scale.

PCDH comprises a core document which presents the plant system I&C life cycle and recaps the main rules to be applied to the plant system I&Cs for conventional controls, interlocks and safety controls. Some I&C topics will be explained in greater detail in dedicated documents associated with PCDH as presented in Figure 1-1. This document is one of them.

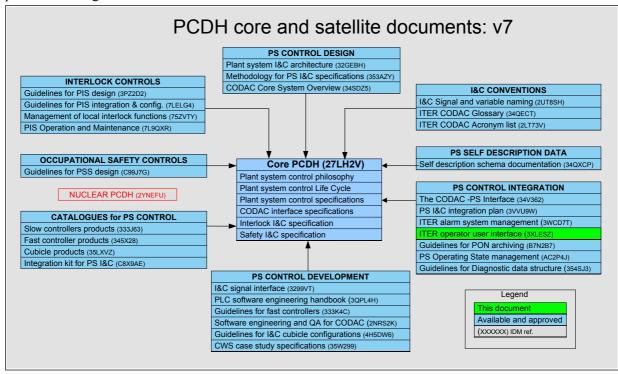


Figure 1-1 Schema of PCDH documents

1.2 **Document Scope**

This guide provides simple and practical guidance to plant system Instrumentation and Control (I&C) responsible officers and designers on how to design, develop, procure, operate and maintain an effective plant system operator user interface.

1.3 Related documents

- [RD1] Plant Control Design Handbook (PCDH). (ITER D 27LH2V v6)
- [RD2] ITER Process for Human Machine Interface (HMI) Development (ITER D 3T9UK2 v1.2)
- [RD3] ITER Human Factor requirements for HMI development (QEDG6L)
- [RD4] CODAC Core System User Manual (ITER D 43PSH9)



1.4 Definitions

Definitions as represented on Figure 1-2 include:

- VDU workstation or "station" is composed of at least 3 VDUs
- VDU or "monitor" 16/9 has a resolution of 3840 x 2160
- Full screen display canvas within CS-Studio environment has a resolution of 3830 x 2080
- A mimic resolution within the display canvas is limited to 3236 x 1760
- A faceplate resolution within the display canvas is limited to 575 x 943

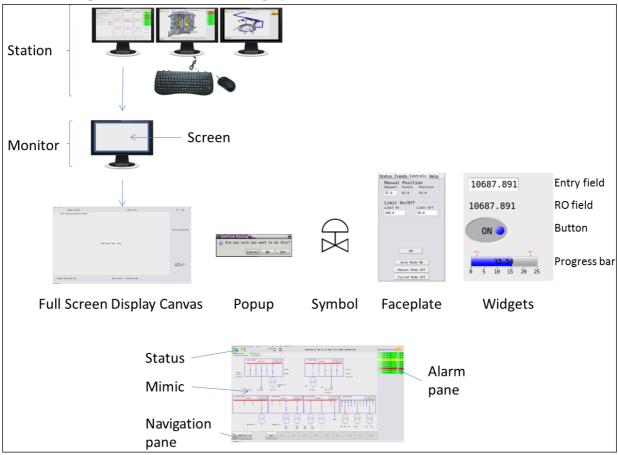


Figure 1-2 HMI Basic Definitions

1.5 **HMI Style Guide**

HMI Style Guide includes general design principles for the displays derived from [RD3]. It describes the displays layout and organisation.

1.6 HMI Toolkit

An HMI toolkit¹ is delivered with CODAC Core System to edit and run displays used to control and monitor systems on the ITER site during and throughout commissioning, operation and maintenance phases. The toolkit is based on CS-Studio (CSS) set of tools that includes an operator interface (BOY), an alarm system (BEAST) and an archive system (BEAUTY).

The HMI toolkit provides standardised colours and fonts, a collection of graphical objects – widgets – that the user can drag and drop from the palette to the display canvas, trend widgets, an industrial symbol library (electrical breaker, valve, pump...) and many templates.

¹ This document refers to the HMI toolkit 4K/Quad HD version. Please consult [RD4] to learn how to switch from Full HD to 4K definition



2 Operator User Interface Layout

The entire screen area visible to the user is the 'display canvas' and has the following specific zones:

- Status Bar
- Main Display Area mimic
- Alarm Pane
- Control Area / Faceplate Pane
- Navigation Pane

Figure 2-1, shows the display canvas layout running on one-terminal using CS-Studio BOY.



Figure 2-1 Display canvas layout

The root element of the screen is the 'Display' widget with some predefined properties, such as the position and the size² as illustrated on Figure 2-2.

▼ Position	
Height	2080
Width	3830
X	Θ
Υ	0

Figure 2-2 Display widget – Position properties

A macro defines the mimic title as shown on Figure 2-3 and is used as widget name.

Property	Value
Basic	
Macros	{Parent Macros} {TITLE=UTIL OVERVIEW}
Name	\${TITLE}
Widget Type	Display

Figure 2-3 Title macro specification during edition

-

² The HMI toolkit provides an automatic scaling tool to adapt Full HD screens to 4K resolution. Consult [RD4] for more information



At runtime, the display is named using the macro \${TITLE} as illustrated on Figure 2-4.



Figure 2-4 Title macro instantiated at runtime

2.1 Status Bar

The primary purpose of the Status Bar is to provide the user with a high-level overview of ITER's overall status and to "set the context" for the station. The status bar includes:

- Global Statuses (CODAC, Central Safety System, Central Interlock System...)
- Mimic Title
- Coordinated Universal Time (UTC) 24-hour time with seconds
- ITER logo

Figure 2-5, shows an implementation of the status bar.

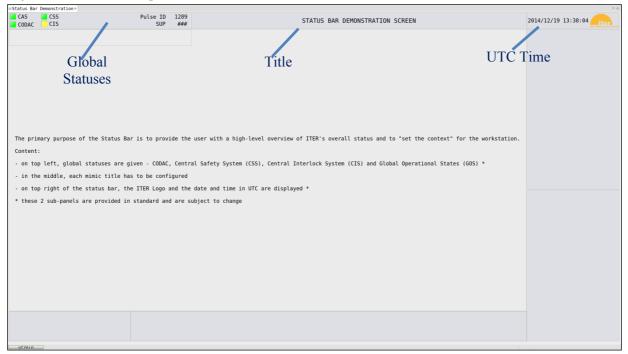


Figure 2-5 Status Bar

Global statuses and UTC time are provided in standard by CODAC as standalone screens to be linked to the screen as illustrated on Figure 2-6.

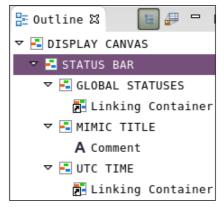


Figure 2-6 Status Bar hierarchy of widgets

To integrate them, a linked folder 'roject name>/src/main/boy/templates' is required that points to



/opt/codac/opi/boy/resources/templates.

Finally, the title of the mimic is displayed in the middle of the status bar, using a Label widget which Text property refers to the title macro defined in the root Display widget as shown on Figure 2-7.

Text	\${TITLE}
------	-----------

Figure 2-7 Label widget – Text property to display the title

2.2 Main Display Area - Mimic

Mimics present representations of the ITER plant systems, sub-systems and any other data and information necessary for user tasks. Mimics provide some control functions that allow users to interact with the plant systems.

2.2.1 Auxiliaries Status

On the top left of the mimic, space is allocated to represent the status of auxiliaries. Figure 2-8, shows an implementation of the plant system auxiliaries status.



Figure 2-8 Auxiliaries Status

A status includes usually a LED widget that shows the Boolean status of the auxiliary:

healthy
not healthy minor
not healthy major

And a Label widget that provides the auxiliary text information.

2.2.2 *Mimic*

In order to display independently a mimic on a wall panel, it is recommended to provide it as a standalone screen to be linked into the canvas as illustrated on Figure 2-9.



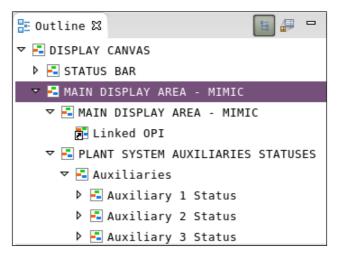


Figure 2-9 Mimic Linked OPI

The mimic itself can be organised using container widgets in different layers as illustrated on Figure 2-10.

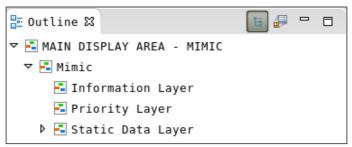


Figure 2-10 Mimic Layers

The size of the mimic is 3236 x 1760.

2.3 Alarm Pane

The alarm pane reflects the alarm status of the controlled system displayed on the mimic – it is specific to each mimic. A first implementation using LED widgets is represented on Figure 2-11.



Figure 2-11 Alarm Pane

Rules and script have been defined to set the background colour according to the severity of the alarm and to display the alarm time. This version of the alarm pane is subject to change.



Figure 2-12 shows the hierarchy of widgets organised in containers setup for maximum 20 active alarm buttons

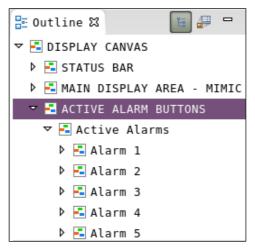


Figure 2-12 Alarm Pane Widgets Hierarchy

2.3.1 Alarm Page

The function of the Alarm Pane is to attract immediate attention of the user to the specific alarm. Clicking on the alarm will open a dedicated screen for alarm handling and investigation.

Figure 2-13 presents an alarm page with the alarm description and procedure, including all relevant data for analysis displayed using trend widgets.

This first implementation does not allow to directly acknowledge the alarm – the control area is disabled. The alarm dedicated display (BEAST) has to be used instead on a second VDU.

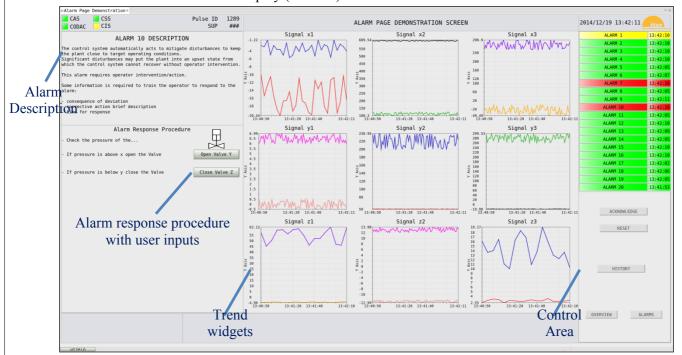


Figure 2-13 Alarm Page



2.4 <u>Control Area / Faceplate Pane</u>

Each controllable component on a mimic shall have a 'faceplate' to provide information about the component and options to control it.

Figure 2-14, shows an implementation of a faceplate displayed when the user clicks on a valve symbol.



Figure 2-14 Faceplate

The faceplate is a linking container as shown on Figure 2-15, which reacts to user click on the controllable component to load the specified faceplate and to instantiate the component macro.

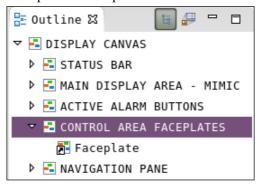


Figure 2-15 Faceplate Linking Container

Faceplates are designed with tabs:

- Status: read-only fields providing information on the status of the component
- Trends: trend widgets displaying historic and live data
- Controls: input fields controlling the component
- Help: containing information about the specific component. Links to datasheet, documentation and information about the physical location of the component are available from this tab.

Some faceplates have been made available under the templates folder for analog components and PID objects, as reported on Figure 2-16.



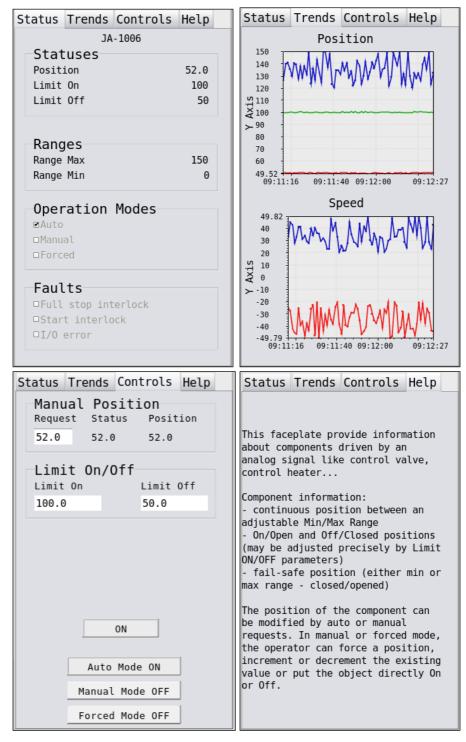


Figure 2-16 Faceplate Tab Container – Status, Trends, Controls, Help



2.5 Navigation Pane

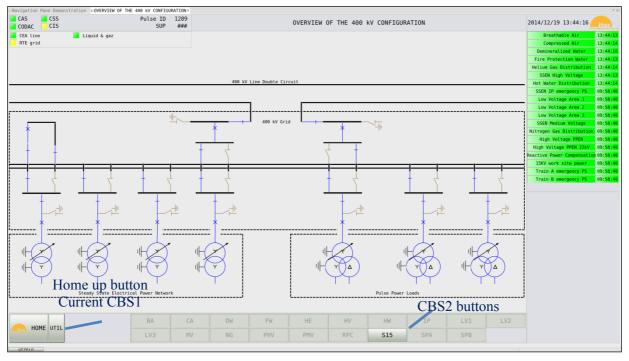
The mimics for plant system users are arranged in a hierarchical structure to allow the user to navigate through the plant system to specific mimics based on the Control Breakdown Structure (CBS), and this in 5 clicks maximum. The navigation pane is divided into two areas:

- General Navigation area with the current location of the mimic and up buttons
- Mimic Navigation which contains the link to other relevant displays.

The following screenshots report an example of the navigation principles³.



Figure 2-17 ITER machine overview (CBS0)



³ Some navigation buttons are greyed out because they are currently not available. The mimics shown in the pictures are for illustrative purposes only.

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Figure 2-18 UTIL overview (CBS1)

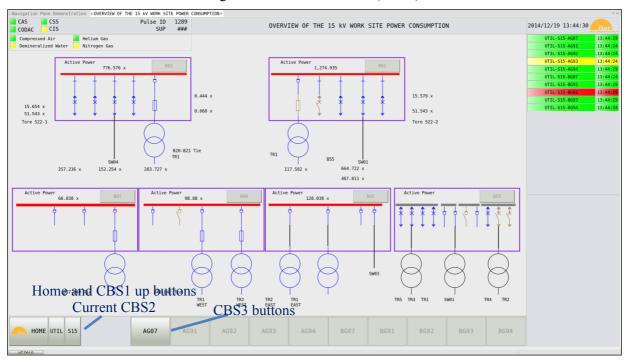


Figure 2-19 UTIL overview (CBS2)

Figure 2-20 shows how button widgets can be organised in the navigation pane.

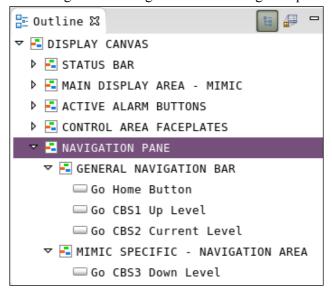


Figure 2-20 CBS2 Navigation Button Widgets



3 Operator User Interface Detailed Design

The HMI toolkit includes fonts and colours definition, templates and examples of all necessary graphic widgets and elements to implement an operator user interface that meets the style guide requirements. During the detailed design, the developer will drag and drop widgets from the palette to the canvas, adjust few properties such as the process variable name and keep the standardised settings in order to achieve a consistent look and feel of the interface.

3.1 Fonts

Styles are predefined and cannot be adjusted by the user. Most of the widgets come with the font already configured. Styles that are permitted for the different types of information to be presented to the user are the following and are illustrated on Figure 3-1:

- IO Title and IO Subtitle for headers and critical operational information,
- IO Label for operational information (e.g. labels, numerical data) presented in mimics and faceplates. This the default font for most of the widgets,
- IO Scale for graph axis.

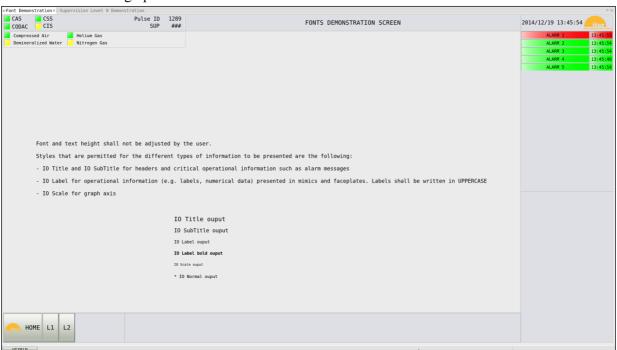


Figure 3-1 Fonts

3.2 Colours

Colours are predefined and cannot be adjusted by the user. Most of the widgets come with the background and foreground colours already configured. As illustrated on Figure 3-2, the main colours are the following:

- IO Background colour for the mimics⁴
- IO Foreground colour for the text and line
- IO Invalid Level Alarm, IO High Level Alarm and IO Medium Level Alarm colours used in conjunction with the 'background alarm sensitive = yes' property
- IO PV OFF and IO PV ON colours for symbol in 0, 1 or more than 1 position

-

⁴ The Menu bar, alarm pane, control area and navigation pane use a different background colour to enlighten them. This IO Area Background colour shall not be used for another purpose



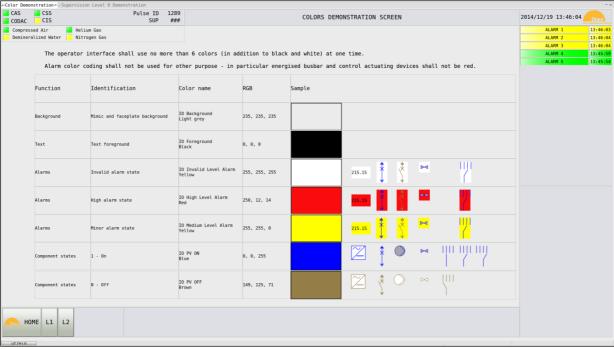


Figure 3-2 Colours

3.3 Symbols

Symbols are predefined and cannot be redesigned. Browse the installed library to select the required component when inserting a Boolean or multistate symbol on the canvas.

Screens describing the library are provided in the HMI toolkit as illustrated on Figure 3-3 as well as electrical and PID diagram examples - Figure 3-4 and Figure 3-5.



Figure 3-3 Valve Fluid Symbols



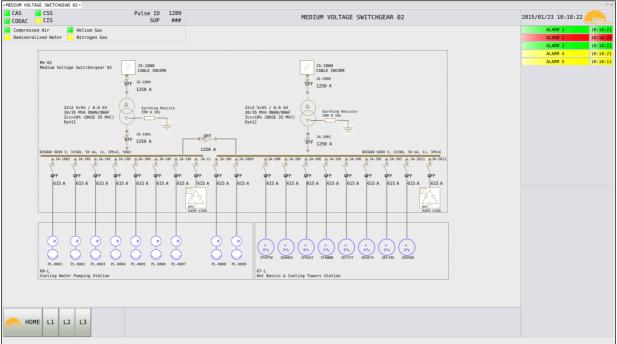


Figure 3-4 Medium Voltage Switchgear Example

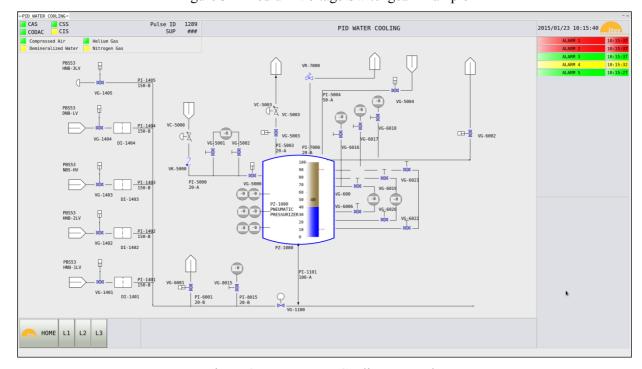


Figure 3-5 PID Water Cooling Example

3.4 Measurement Units and Precision

Measurement units are standardised. Widgets used to displayed process variable value, retrieve and show the unit as well as the precision from the EPICS PV. No measurement unit and no precision should be hardcoded in the HMI.

3.5 Labelling

Label widgets are predefined to be left-justified.



3.6 Mimics

Information may be presented on mimics in the following formats:

- Schematic diagrams cf. previous Figure 3-4 and Figure 3-5
- Isometric diagrams using an image widget to display a SVG image in the background as illustrated on Figure 3-6
- Lists using label widgets
- Tables designed using containers with ridged border style as illustrated on Figure 3-7
- Fields using text update widget for read-only field and text input for entry field. Each widget has a different representation as illustrated on Figure 3-8
- Graphs

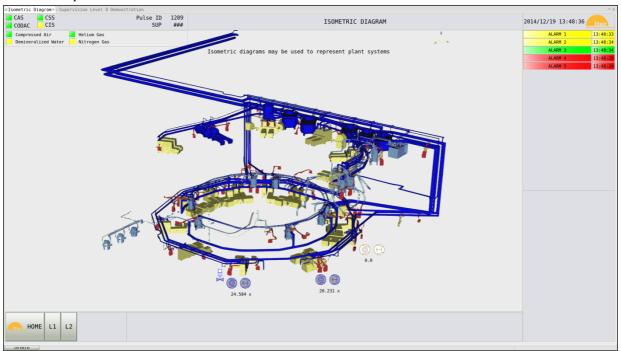


Figure 3-6 Isometric Diagram Example





Figure 3-7 Table Example



Figure 3-8 Fields Example

Finally, Figure 3-9 provides the look and feel of all the available widgets in the HMI toolkit, including:

- Graphics: label, image, ellipse, rectangle, polyline...
- Monitors: text update, LED, progress bar, tank...
- Controls: text input, action button, Boolean button, choice button, combo box and check box...
- Symbols: Boolean symbol and multistate symbol



Figure 3-9 Widgets library



3.7 Interaction

A new value entered in an entry field requires a confirmation before being sent to the process. If input validation is required, this can be achieved by adding logic on EPICS or directly on the operator interface via Python script.

Figure 3-10 provides an example where:

- The user enters a request: new required position is 78.0
- The process receives the change request, processes it and accepts the command: the request status is 78.0 to confirm its acceptation by the process
- The current position is changing: the position is updated, the field is flashing until the requested position is achieved



Figure 3-10 User Input and Feedback Example